Big River Reservoir
Rhode Island

214

Supplemental Report To July 1981 Interim Feasibility Report and Final Environmental Impact Statement

US Army Corps
of Engineers
New England Division

FEBRUARY 1982

SUPPLEMENTAL REPORT TO JULY 1981
FEASIBILITY REPORT ON
BIG RIVER RESERVOIR, RHODE ISLAND

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INTRODUCTION

This supplement to the July 1981, Pawcatuck & Narragansett Bay Drainage Basins, Rhode Island, Big River Reservoir Interim Feasibility Report, has been developed to address concerns that arose during the final stages of study review. These concerns focus primarily on the following three major areas:

- a reevaluation of water supply needs based upon the latest U.S. Census and current data regarding population projections prepared by the Bureau of Economic Analysis
- the economic, environmental and social impacts resulting from reduction of natural flows in the South Branch and mainstem Pawtuxet River as a result of the Big River impoundment
- the adequacy of the proposed plan for wildlife mitigation.

Changes have been made as necessary. However, no appreciable changes have occurred in the Recommended Project.

WATER SUPPLY REQUIREMENTS

Population. Municipal and industrial water supply needs through the year 2030 as presented in the Feasibility Report, are derived in large part from an analysis of population and economic development projected for the study area. These needs were based upon population data prepared by the Rhode Island Statewide Planning Program in 1975 and an analysis of existing water supply systems serving the study area. There is public concern on the need for additional water supplies, in view of reported declining population growth rate in the study area and the State; therefore, a reevaluation has been conducted to determine needs based upon the latest projections of population developed by the U.S. Department of Commerce, Bureau of Economic Analysis, and 1980 Federal census results.

The 1980 OBERS projections prepared by the Bureau of Economic Analysis are available for the entire State of Rhode Island and for the Providence-Pawtucket-Warwick SMSA. The latter contains all of the study area communities. Population projections were compared with figures obtained from the 1980 Census for all of Rhode Island and then disaggregated for communities within the study area. Projections for each community for the planning years 2000 and 2030 were derived from an analysis of community trends identified by the State of Rhode Island in recent studies. Estimates of total population and population served by public water supply systems for the study area are shown in Table 1. Plate 1 graphically shows population growth projected for the study area and the entire State. Rhode Island Statewide Planning Program projections from 1975 and 1979 are shown for comparison with the 1980 OBERS projections.

TABLE 1

POPULATION PROJECTIONS FOR STUDY AREA

Community	Total Population			Population Served	
	1980 Census	2000	2030	2000	2030
Barrington	16,174	19,600	19,500	19,600	19,500
Bristol	20,178	22,900	24,300	22,900	24,300
Warren	10,640	11,800	13,300	11,800	13,300
Cranston	71,992	85,200	96,500	85,200	96,500
Providence	156,804	160,600	172,400	160,600	172,400
Johnston	24,907	30,800	35,400	27,700	35,400
North Providence	29,188	32,800	38,300	27,500	32,200
East Providence	50,980	58,300	66,300	58,300	66,300
Smithfield	16,886	19,000	25,800	16,700	25,800
Warwick	87,123	106,800	122,300	106,800	122,300
East Greenwich	10,211	12,400	15,500	12,400	15,500
West Greenwich	2,738	3,900	4,400	2,700	4,400
Coventry	27,065	36,700	44,200	36,700	44,200
Scituate	8,405	9,800	11,000	6,200	11,000
West Warwick	27,026	31,400	33,200	31,400	33,200
Foster	3,370	3,900	4,300	2,100	4,300
Glocester	7,550	9,200	10,200	5,100	10,200
TOTAL STUDY AREA	571,187	655,100	736,900	633,700	730,800
TOTAL STATE	947,154	1,086,400	1,222,100		

Source: 1980 U.S. Census, BEA/OBERS population projections.

Estimated Water Demands. Future water demands were estimated for residential, commercial and industrial usage based upon the methodology described in the Feasibility Report. The estimates of population served were derived from 1980 OBERS projections. Table 2 shows total public water supply projections for the study area based upon expected trends in residential water usage. Future demands projected for existing water supply systems serving the study area with and without implementation of a water conservation program are shown in Table 3 and graphically displayed on Plate 2.

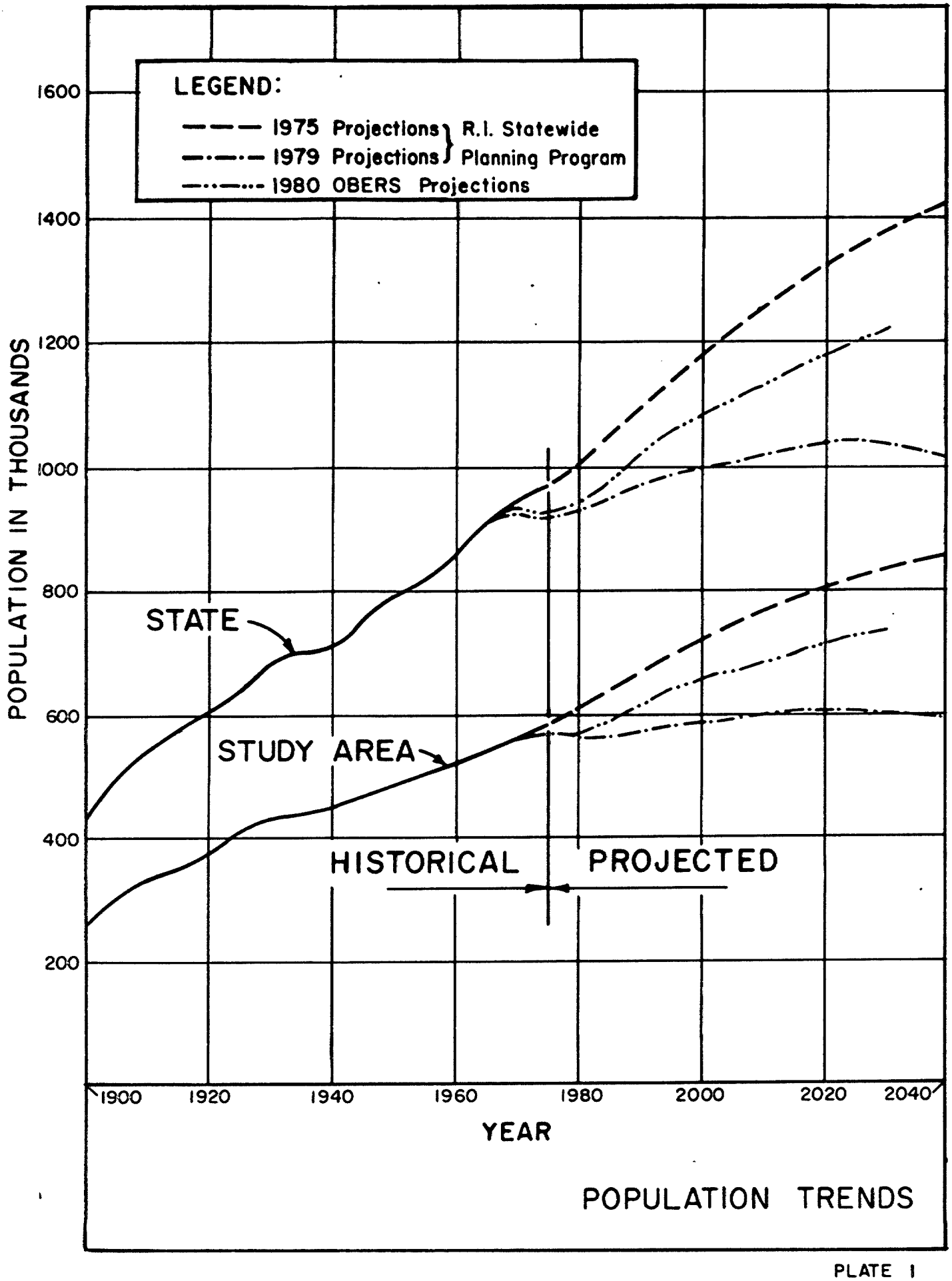
LEGEND:
1975 Projections
1979 Projections
R.I. Statewide Planning Program
1980 OBERS Projections
POPULATION IN THOUSANDS
1600
1400
1200
1000
800
600
400
200
STATE
STUDY AREA
HISTORICAL
PROJECTED
1900
1920
1940
1960
1980
2000
2020
2040
YEAR
POPULATION TRENDS

PLATE 1

TABLE 2

MUNICIPAL WATER SUPPLY PROJECTIONS FOR STUDY AREA
(Million gallons per day)

Water Supply Agency	Communities Served	1975 Demands Avg.	1975 Demands Max.	2000 Demands Avg.	2000 Demands Max.	2030 Demands Avg.	2030 Demands Max.
Bristol County Water Company	Barrington Bristol Warren	3.4	5.8	5.4	9.3	6.9	11.9
Providence Water Supply Board	Cranston Providence Johnston North Providence East Providence Smithfield Warwick	62.4	106.0	81.5	139.1	104.7	178.7
Kent County Water Authority	East Greenwich West Greenwich Coventry Scituate West Warwick	6.0	12.4	11.1	22.7	15.2	31.1
	Foster	0	0	0.2	0.3	0.4	0.7
	Glocester	0	0	0.4	0.9	1.0	2.0
TOTAL STUDY AREA		71.8	124.2	98.6	172.3	128.2	224.4

TABLE 3

ESTIMATED REQUIREMENTS OF EXISTING
WATER SUPPLY AGENCIES
(Million gallons per day)

WITHOUT CONSERVATION

Water Supply Agencies	2000		2030	
	Average	Maximum	Average	Maximum
Bristol County Water Company	5.4	9.3	6.9	11.9
Providence Water Supply Board	81.5	139.1	104.7	178.7
Kent County Water Authority	11.1	22.7	15.2	31.1
TOTAL	98.0	171.1	126.8	221.7

WITH CONSERVATION

Water Supply Agencies	2000		2030	
	Average	Maximum	Average	Maximum
Bristol County Water Company	4.9	8.5	6.1	10.6
Providence Water Supply Board	74.2	126.6	93.1	159.0
Kent County Water Authority	10.1	20.6	13.6	27.7
TOTAL	89.2	155.7	112.8	197.3

Analysis of Water Supply Needs. Estimates of future water requirements for the study area, based upon 1980 OBERS population projections are shown on Plate 1. They indicate that additional supplies would be needed as early as 1995 should no water conservation measures be implemented, and by about the year 2005 should projected demands be modified by a conservation program. These findings are based on the assumption that 1) the safe yield and maximum capacity of existing surface and groundwater supply sources will remain undiminished in quantity and quality over the planning timeframe, 2) no significant water demand increases will result from unanticipated industrial development in the study area, 3) additional groundwater resources will be developed to augment the existing Bristol County Water Company supply system in order to satisfy that system's

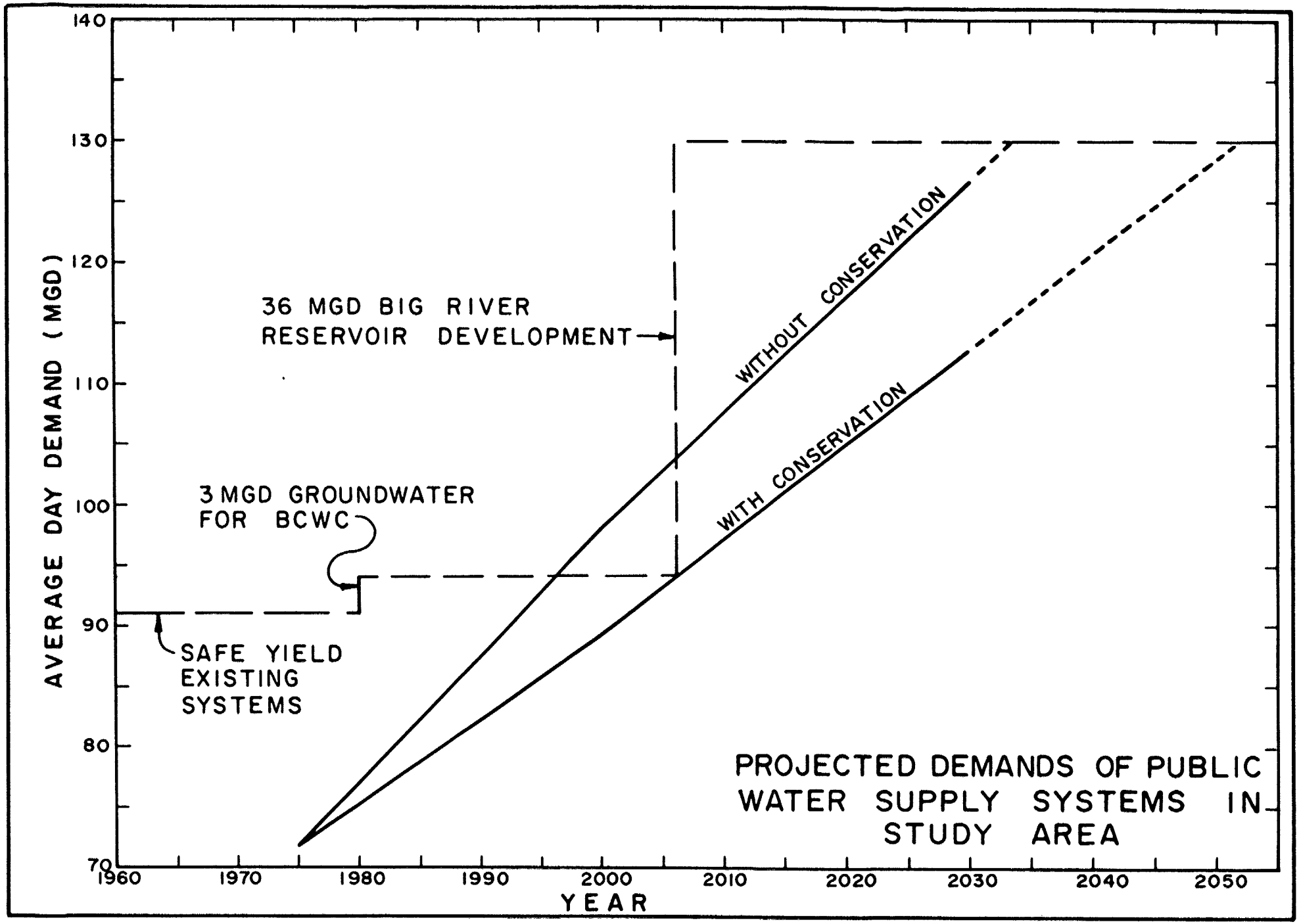
AVERAGE DAY DEMAND (MGD)
140
130
120
110
100
90
80
70
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
YEAR
36 MGD BIG RIVER RESERVOIR DEVELOPMENT
3 MGD GROUNDWATER FOR BCWC
SAFE YIELD EXISTING SYSTEMS
WITHOUT CONSERVATION
WITH CONSERVATION
PROJECTED DEMANDS OF PUBLIC WATER SUPPLY SYSTEMS IN STUDY AREA

PLATE 2

present short-term supply needs, and 4) water conservation program to reduce both future average day and maximum day water requirements could be successfully implemented by State and local authorities.

PROPOSED FEDERAL PROJECT

This section provides economic information on the proposed Federal project, as described in the Feasibility Report and shown on Plate G-2 in Appendix G, "Design and Cost Estimates." Costs, benefits, cost allocation and apportionment, and economic justification of the proposed project are described below, including changes resulting from reevaluation of certain project elements. All costs and benefits cited in this Supplemental Report update and modify the corresponding figures presented in the Feasibility Report.

Costs. Construction costs of the proposed Federal project are based on June 1981 price levels. An interest rate of 7-5/8 percent and an amortization period of 100 years has been used for computing annual charges on project investment. Project first costs are as presented in the Feasibility Report, with the exception of mitigation costs, which no longer include costs for fisheries management. These costs are included in the total costs for recreation.

Annual charges are increased due to the cost of displaced recreation on the project site, which is included as a project cost instead of being applied against recreation benefits as proposed in the Feasibility Report. Annual recreation costs are increased due to increased charges for fisheries management.

Project first costs and annual costs are shown in Table 4.

TABLE 4

SUMMARY OF ESTIMATED COSTS
(June 1981 Price Level)

First Costs

Reservoir	
Relocations	$ 4,735,000
Reservoir Clearing	2,390,000
Dam	3,318,000
Outlet Works	1,736,000
Spillway	3,167,000
Impervious Blanket	4,023,000
Raw Water Conduit	1,044,000
Roads, Buildings, Equipment	348,000
Lands and Damages	22,281,000
Subtotal Reservoir:	$43,042,000

TABLE 4 (Cont'd)

SUMMARY OF ESTIMATED COSTS
(June 1981 Price Level)

Mitigation		
Cultural Resources		$ 476,000
Natural Resources		1,402,000
Lands and Damages		15,280,000
Subtotal Mitigation:		$17,158,000
Recreation		$ 671,000
Contingencies		4,662,000
Engineering and Design		3,357,000
Supervision and Administration		2,237,000
	TOTAL PROJECT FIRST COST	$71,127,000
Interest During Construction		10,847,000
	TOTAL INVESTMENT	$81,974,000

Annual Costs

Interest & Amortization (7-5/8%, 100 yrs.)	$ 6,255,000
Displaced Recreation	145,000
Operation & Maintenance	356,000
Major Replacements	1,000
TOTAL ANNUAL COST	$ 6,757,000

Benefits. Flood control benefits from the Big River Reservoir project are derived from damages prevented to existing structures and expected growth until 1995. Average annual benefits are estimated at $860,000 and occur primarily in the communities of West Warwick, Cranston and Warwick. This amount is unchanged from the previously reported figures in the Feasibility Report. Water supply benefits are estimated based upon the least cost alternative, a single-purpose water supply project at the Big River site, and have been updated to $6,483,000 annually, using the increased interest rate. Recreational benefits have been updated from the Feasibility Report using the annual attendance by activity and unit day value method in accordance with the 14 December 1979 Water Resources Council Procedures for Evaluation of National Economic Development Benefits and Costs in Water Resources Planning, updated as of 31 July 1981. Table 5 shows annual attendance and benefits with and without the project broken down by activity.

Average annual recreation benefits for the existing level of activity at the project site are estimated to be $145,000. The proposed recreation plan provides an estimated $256,000 in average annual benefits, thus furnishing a net gain of $111,000 annually. The estimated total average annual benefits for the project are therefore $7,599,000.

TABLE 5

RECREATIONAL BENEFITS

Existing[1] Conditions	Value of Recreation	Annual Attendance Without Reservoir 1995	Annual Attendance Without Reservoir 2020	Annual Benefits Without Reservoir 1995	Annual Benefits Without Reservoir 2020
Boating	$2.40	5,300	12,200	$ 12,720	$ 29,280
Camping	2.80	0	0	0	0
Fishing	2.70	8,000	10,900	21,600	29,430
Hiking	2.10	1,400	1,900	2,940	3,990
Horse Riding	3.00	2,100	3,700	6,300	11,100
Hunting	3.20	5,700	10,500	18,240	33,600
Picnicking	2.40	4,200	4,200	10,080	10,080
Swimming	2.90	14,600	21,100	42,340	61,190
TOTAL				$114,220	$178,670
			Rounded	$114,000	$179,000

Proposed Plan	Value of Recreation	Annual Attendance With Reservoir 1995	Annual Attendance With Reservoir 2020	Annual Benefits With Reservoir 1995	Annual Benefits With Reservoir 2020
Boating	$2.40	8,800	17,600	$ 21,120	$ 42,240
Camping	2.80	3,300	6,600	9,240	18,480
Fishing	2.70	12,500	18,750	33,750	50,625
Hiking	2.10	4,400	5,500	9,240	11,550
Horse Riding	3.00	2,800	4,700	8,400	14,100
Hunting	3.20	6,900	12,100	22,080	38,720
Picnicking	2.40	8,300	8,300[2]	19,920	19,920
Swimming	2.90	26,300	42,100	76,270	122,090
TOTAL				$200,020	$317,725
			Rounded	$200,000	$318,000

Remarks:

[1]Represents existing recreation opportunities lost due to inundation by the reservoir.

[2]Future picnicking demand is limited; no attendance growth is anticipated 2030.

Cost Allocation. Costs are allocated to each project purpose using the separable cost - remaining benefits (SCRB) method. Alternative dual- and single-purpose projects were compared with the multi-purpose project to develop separable costs. Pertinent data on each alternative project used in the cost allocation analysis is presented in Table 6.

TABLE 6

PERTINENT DATA - ALTERNATIVE PROJECTS

	DUAL PURPOSE			SINGLE PURPOSE		
	Water Supply and Recreation	Flood Control[1] and Recreation	Water Supply[2] and Flood Control	Flood Control	Water Supply	Recreation
Elevations: (ft)						
Top of Dam	309	281	312	276	309	N/A
Spillway Crest	300	270	303	265	300	N/A
Flood Control Pool	N/A	270	303	265	N/A	N/A
Water Supply Pool	300	N/A	300	N/A	300	N/A
Storage: (acre-feet)						
Flood Control	0	9,500	9,500	9,500	N/A	N/A
Water Supply	73,600	0	73,600	N/A	73,600	N/A
Conservation	12,300	5,500	12,300	0	12,300	N/A
Impoundment Area (acres)	3,240	1,200	3,400	870	3,240	N/A
Total Land Required (acres)	8,300	1,420	8,300	1,400	8,300	50

Remarks:

1. Includes a recreation pool at Elev. 261 (Storage 5,500 ac-ft).

2. Lands required same as for multi-purpose project.

Cost estimates have been revised for each alternative project reflecting changes from those presented in the Feasibility Report. Construction costs are less for single- and dual-purpose water supply and flood control projects as no facilities are developed to replace existing recreation displaced by each project. Mitigation costs are less for all alternative plans as fisheries management is included in the total cost for recreation.

Annual costs for each alternative project have been revised to include the cost of existing recreation displaced. This cost varies depending upon the degree of development called for in each alternative project.

Operation and maintenance costs for alternative single- and dual-purpose water supply and flood control projects have been revised to exclude recreation replacement costs previously included. Recreation operation and maintenance costs are increased due to the inclusion of charges for fisheries management.

Multi-purpose project costs have been revised to reflect those elements considered use specific. Recreation construction and operation and maintenance costs are considered specific to the recreation purpose of the project. However, recreation lands are considered joint-use as they are completely bounded by lands required for joint-use purposes and would be acquired for severance reasons regardless.

The allocation of costs for the proposed Federal project is shown in Table 7.

Economic Justification. As shown in Table 7, comparison of average annual benefits and average annual costs results in a benefit to cost ratio of 1.12 to 1 for the entire multi-purpose project. Benefit to cost ratios for each of the project purposes are 1.41, 1.09, and 1.32 to 1 for the flood control, water supply, and recreation purposes respectively.

Cost Apportionment. General legislation authorizing implementation of water resource projects, the most recent being the Water Resources Development Act of 1976, generally contained local cooperation requirements established by enactment of various laws. This report contains information based upon application of these traditional requirements. The Administration is reviewing project cost sharing and financing across the entire spectrum of water resource development functions and has submitted proposed legislation to Congress for navigation projects. The basic principle governing the development of specific cost-sharing policies is that whenever possible the cost of services produced by water projects should be paid for by their direct beneficiaries. It also is recognized that the Federal Government can no longer bear the major portion of the financing of water projects. New sources of project financing, both

TABLE 7

ALLOCATION OF PROJECT COSTS
(In $1000 at June 1981 Price Level)

	ALTERNATIVE DUAL PURPOSE PROJECTS			ALTERNATIVE SINGLE PURPOSE PROJECTS		
	WS & REC.	FC & REC	WS & FC	FC	WS	REC
1. CONSTRUCTION PERIOD (YEARS)	4	2	4	2	4	2
2. INVESTMENT AND ANNUAL CHARGES						
a. Construction Expenditure	69,719	18,085	70,158	16,829	68,755	985
b. Interest During Construction	10,632	1,379	10,699	1,283	10,485	75
c. Present Val.of Future Rec.Fac.	-	-	-	-	-	-
d. Total Investment	80,351	19,464	80,857	18,112	79,240	1,060
e. Annual Charges						
Interest] Amortization	6,131	1,485	6,169	1,382	6,046	81
Operation & Maintenance	356	272	291	224	291	65
Major Replacements	1	-	1	-	1	-
Loss of Recreation	145	70	145	65	145	70
Net Loss to Fish & Wildlife	-	-	-	-	-	-
f. TOTAL ANNUAL CHARGES	6,633	1,827	6,606	1,671	6,483	216

MULTIPLE-PURPOSE PROJECT

	SPECIFIC COSTS			Joint Use Cost	TOTAL
	FC	WS	REC		
3. CONSTRUCTION PERIOD (YEARS)					4
4. INVESTMENT & ANNUAL CHARGES					
a. Construction Expenditure	-	1,500	966	68,661	71,127
b. Interest During Construction		229	147	10,471	10,847
c. Present Val. of Future Rec. Fac.					
d. Total Investment	-	1,729	1,113	79,132	81,974
e. Annual Charges					
Interest] Amortization	-	132	85	6,038	6,255
Operation & Maintenance	-	12	65	279	356
Major Replacements	-	-	-	1	1
Loss of Recreation	-	-	-	145	145
Net Loss to Fish & Wildlife	-	-	-	-	-
f. TOTAL ANNUAL CHARGES	-	144	150	6,463	6,757

TABLE 7 (Cont'd)

ALLOCATION OF PROJECT COSTS
(In $1000 at June 1981 Price Level)

	SPECIFIC COSTS			Joint Use Cost	TOTAL
	FC	WS	REC		
5. ALLOCATION OF ANNUAL CHARGES					
a. Benefits	860	6,483	256	-	7,599
b. Alternate Cost	1,667	6,483	216	-	8,370
c. Benefits Limited by Alternate Cost	860	6,483	216	-	7,559
d. Separable Cost	124	4,930	151	-	5,205
e. Remaining Benefits	736	1,553	65	-	2,354
f. Ratio of Remaining Benefit - %	31.27	65.97	2.76	-	100.00
g. Allocated Joint Costs	485	1,024	43	-	1,552
h. TOTAL ALLOCATION, PROJECT COST	609	5,954	194	-	6,757
6. ALLOCATION OF LOSS-RECREATION					
a. Separable Costs	0	75	0	-	75
b. Allocated Joint Costs	22	46	2	-	70
c. Total Allocations	22	121	2	-	145
7. ALLOCATION OF O&M					
a. Separable Costs	0	84	65	-	149
b. Allocated Joint Costs	65	136	6	-	207
c. Total Allocation	65	220	71	-	356
d. Specific Costs	0	12	65	-	77
e. Allocated Joint-Use Costs	65	208	6	-	279
8. ALLOCATION OF MAJOR REPLACMENTS					
a. Separable Costs	0	0	0	-	0
b. Allocated Joint Costs	0	1	0	-	1
c. Total Allocations	0	1	0	-	1
9. ALLOCATION OF INVESTMENT & FIRST COSTS					
a. Annual Investment	522	5,612	121	-	6,255
b. Allocated Investment	6,845	73,541	1,588	-	81,974
c. Present Val. of Future Rec. Fac.	-	-	-	-	-
d. Ratio of Allocated Annual Investment - %	8.351	89.712	1.937	-	100.00
e. Initial Construction Expenditure	5,940	63,809	1,378	-	71,127
10. ALLOCATION OF CONSTRUCTION EXPENDITURE					
a. Specific Envestment	0	1,729	1,113	-	2,842
b. Investment in Joint-Use Facilities	6,845	71,812	475	-	79,132

TABLE 7 (Cont'd)

ALLOCATION OF PROJECT COSTS
(In $1000 at June 1981 Price Level)

		SPECIFIC COSTS			Joint Use	
		FC	WS	REC	Cost	TOTAL
10.	ALLOCATION OF CONSTRUCTION EXPENDITURE					
	c. Interest During Const., Joint-Use Facilities	906	9,502	63	-	10,471
	d. Const. Expenditures in Joint-Use Facilities	5,940	62,309	412	-	68,661
	e. Ratio of Const. Exp. in Joint-Use Facilities	8.650	90.749	.600	-	100.00
	f. Construction Expenditures in Specific Facilities	0	1,500	966	-	2,466
	g. Total Construction Expenditures	5,940	63,809	1,378	-	71,127
11.	SUMMARY					
	a. Total Construction Expenditures	5,940	63,809	1,378	-	71,127
	b. Annual Costs	609	5,954	194	-	6,757
	c. Annual Benefits	860	6,483	256	-	7,599
	d. Benefit/Cost Ratio	1.41	1.09	1.32	-	1.12

public and private, will have to be found. While specific policies applicable for the Big River Reservoir project have not yet been established, non-Federal interests can expect that, under the Administration's financing and cost-sharing principles, the level of their finanical participation will need to be significantly greater than in the past.

Cost apportionment between Federal and non-Federal interests is shown in Table 8. Costs are apportioned in accordance with the same policies as cited in the Feasibility Report. Differences in apportionment result from revised project first costs and annual costs, which have slightly altered the allocation of costs among project purposes, and from the inclusion of displaced recreation costs. Recreation cost apportionment reflects revisions to specific and joint-use recreation costs.

Credit for the cost of project lands owned by the State of Rhode Island is shown in Table 8. This credit is applied as an in-kind contribution for the non-Federal share of total project costs where appropriate.

TABLE 8

COST APPORTIONMENT
(In $1000 at June 1981 Price Level)

PROJECT FIRST COSTS

Conventional Cost Sharing

	Flood Control	Water Supply	Recreation	Total
Federal	$5,940	$ -	$895	$ 6,835
Non-Federal	-	63,809	483	64,292
Credit for land*	-	37,078	483	37,561
Total Project	$5,940	$26,731	$895	$33,566

President Carter's Proposed Cost Sharing

	Flood Control	Water Supply	Recreation	Total
Federal	$4,455	$ -	$826	$ 5,281
State	297	6,381	69	6,747
Non-Federal	1,188	57,428	483	59,099
Credit for land*	1,188	35,890	483	37,561
Total Project	$4,752	$27,919	$895	$33,566

*State-owned project lands.

ANNUAL CHARGES

	Flood Control	Water Supply	Recreation	Total
Federal				
Interest & Amort.	$522	-	$78	$600
Operation & Maint.	65*	-	6*	71
Major Replacements	-	-	-	0
Displaced Recreation	22	-	2	24
Total Federal	$609	0	$86	$695

	Flood Control	Water Supply	Recreation	Total
Non-Federal				
Interest & Amort.	-	$5,612	$43	$5,655
Operation & Maint.	-	220	65	285
Major Replacements	-	1	-	1
Displaced Recreation	-	121	-	121
Total Non-Federal	0	$5,954	$108	$6,062

*Estimated Operation and Maintenance cost for on-site flood control activities ($40,000) and joint-use recreation ($6,000) would be assumed by non-Federal interests and reimbursed by the Federal Government.

DOWNSTREAM IMPACTS

Operation of the proposed Big River Reservoir for maximum dependable water supply would markedly reduce average annual flows on the South Branch of the Pawtuxet River. The project would also have the potential of reducing average annual flows on the mainstem Pawtuxet River by as much as 15 percent. The minimum average reservoir release would equal the 10-year frequency, 7-day minimum flow rate on the South Branch, considered necessary to maintain adequate assimilation capacity for downstream waste discharges. Under normal flow conditions, there would not be any significant impacts on downstream aquatic biota.

Existing water quality conditions in the South Branch and mainstem Pawtuxet River are poor, with the waters rated no higher than Class C by the Rhode Island Division of Water Pollution Control. The biological productivity of the waters is limited, although conditions are not anaerobic. There are no anadromous fisheries restoration programs proposed for the Pawtuxet River as the poor water quality conditions are not expected to improve appreciably in the future even with implementation of various proposed pollution abatement projects.

The impact of minimum releases from the proposed reservoir on downstream water users would not be significantly changed from present low flow conditions. Reduced average flows, especially in the South Branch, could create significant impacts on downstream users. The Quidnick Reservoir Company, an association of mill owners along the South Branch and mainstem Pawtuxet River and operators of the existing Flat River Reservoir, utilizes river flows for various industrial activities including the manufacture of textile products, chemicals and allied products, rubber and miscellaneous plastics products, machinery, and other miscellaneous goods. Reduced flows would affect these industries in a variety of ways. Processes using cooling water would be primarily affected by the quantity of water available whereas those industries with dyeing processes would be impacted by reduced quality of raw water intake and waste assimilation capacity if present operations were to continue throughout the planning timeframe.

In addition, reduced flows would impact on potential hydroelectric projects under investigation by some member companies of the Quidnick Reservoir Company. Application data submitted for licenses to the Federal Energy Regulatory Comission indicate that four potentially feasible redevelopment projects on the South Branch and one project on the Pawtuxet River mainstem in West Warwick would have total installed capacity of about 1.5 megawatts producing an estimated 8.7 million KWH of electrical energy that is planned to be sold to the local electrical utility.

The severity of the adverse effects of reduced flows on downstream water users is not known at this time. Operation of the proposed Big River Reservoir in combination with the existing Scituate and Flat River reservoirs for optimum water supply and flood control would have a direct bearing on the severity of potential adverse impacts. It is expected that reservoir regulation prior to the need for maximm water supply from the Big River-Scituate system would provide for maintenance of normal river flows as nearly as possible thereby minimizing adverse impacts on downstream water users.

A reservoir regulation plan, incorporating an evaluation of downstream water requirements and impacts resulting from construction of the project, would be developed during advanced engineering and design studies should the project be authorized for construction.

MITIGATION PLANNING

Summary. The Corps' proposed terrestrial management plan incorporates many of the recommendations provided by the U.S. Fish and Wildlife Service (USFWS), the Rhode Island Department of Environmental Management (DEM), and consultant's mitigation reports. However, the Corps plan does not recommend additional land acquisition as did USFWS (5800 acres) and Rhode Island DEM (1,500-2,000 acres). The rationale for not recommending additional land acquisition follows.

As explained in the EIS, and in accordance with the Fish and Wildlife Coordination Act, the Corps must develop a plan which presents justifiable means and measures for wildlife resources that should be implemented to obtain maximum overall project benefits. This does not necessarily have to include 100 percent mitigation of lost resources. At this stage of study, proposed management of the surrounding reservoir lands represents the level of fish and wildlife mitigation which the Corps feels is viable and justifiable and in the public interest in conjunction with the proposed Big River Reservoir project. The recommended Corps mitigation plan would be on lands contiguous with the impoundment area, making management activities more concentrated and cost effective. Acquisition and management of real estate beyond the immediate impoundment area, as inferred by the USFWS, would aggravate socio-economic impacts of the project. Political considerations would be compounded, as additional real estate acquisition would likely be in areas that do not realize water supply benefits from the project. Thus one objective of the Corps proposal was to eliminate the need for additional land acquisition, thus precluding associated socio-economic and political complications.

Additionally, the Corps used different assumptions concerning future with and without project conditions. The Corps proposal was based on the assumption that lands in the project site would revert to private ownership if the reservoir is not constructed. As a result, there would be a decline in overall habitat potential due to man-made changes in the area. The capability of the different vegetative types to support certain

species in the project site would decrease. There would be little or no wildlife management on the project site under private ownership. The baseline HSI values of the existing habitat types would decline.

Over the years, there would be a decline in the utilization of the land for hunting, fishing and general recreation. Although State of Rhode Island officials feel that the lands would remain in public ownership, they also stated that there already is, and would be in the future, pressure from surrounding communities to revert to private ownership. The State is putting little management effort into the lands at the present time.

Under private ownership, sand and gravel would continue to be removed and the areas expanded. Once supplies are exhausted, the land would most likely be developed and would not revert back to the original habitat type.

The USFWS concluded that under without project conditions, the total annualized change of habitat units is relatively insignificant. Under the without project condition of private ownership, the change in overall habitat units would be significant as a result of the decline in productivity.

Under future conditions with the project, there would remain approximately 3600 acres available for management to mitigate the losses to wildlife resources. Management would be initiated with project construction. As recommended by USFWS, wildlife management practices in certain areas of the reservoir would be those which are compatible with the recreational use proposed for the area.

The Corps proposal further provides for grading only of the remaining pit areas. Topsoiling and seeding of these areas would be extremely expensive. Grading would allow natural succession of native vegetation types which would increase species diversity and provide nesting, denning, or perching sites for many wildlife species. The Corps agrees with the assumption of USFWS that the State would make every effort to remove sand and gravel deposits before project completion, with the overall area of pits doubling in size.

The Corps proposal recommends three subimpoundment sites located by USFWS as identified in the EIS. These sites total approximately 90 acres, including only those areas which would be under 4 feet or less of water. (See Subimpoundments section following).

The water supply pool would have some value for wildlife species in the area. During reservoir fluctuations in the summer months, exposed herbaceous vegetation would provide food and cover for waterfowl and other aquatic species. Small terrestrial mammals would also be able to utilize the shoreline resources for food and cover.

Although the proposed Corps of Engineers terrestrial management plan may not mitigate 100 percent of the losses due to project implementation the proposed measures are consistent with project purposes and are viable measures. Management techniques proposed for the deciduous/evergreen forest/shrubland habitat, sand and gravel pits, and the agricultural and open lands would compensate for much of this kind of habitat that would be affected.

Wetland losses are extremely difficult to mitigate even with the acquisition and management of lands outside the study area. The construction and management of three subimpoundments, along with management of the scrub/shrub and forested wetland habitats would mitigate to some extent the loss of wetland habitat in a practical and viable manner.

Based on the above discussion and assumptions and that similar or in-kind habitat would be difficult to locate in Rhode Island for additional acquisition, the proposed Corps wildlife mitigation measures represent an adequate and viable plan that is consistent with project purposes.

Costs of Wildlife Management Plan. The Corps' terrestrial management proposal outlined in the EIS estimated an annual operation and maintenance cost of $227,000 (1981 dollars). Further investigation and coordination with the State of Rhode Island resulted in the revision of both personnel and operation costs as shown in Table 9. Personnel costs have been reduced to reflect current State of Rhode Island salary scales. Additionally, the cost of habitat management and road maintenance has been reduced. The estimated annual operation and maintenance cost totals $101,500.

Management measures proposed in the Corps and USFWS plans are basically the same. The Corps plan, however, includes grading only of the sand and gravel pits, and no additional land acquisition. The USFWS estimates become substantially higher when seeding and topsoiling costs of the pits are included, in addition to management costs of 5800 acres of additional mitigation land. The Rhode Island DEM concurred with the Corps estimates in their comments on the Draft EIS. They stated: "The Fish and Wildlife Plan proposed by the Corps presents low cost, easily implementable methods to compensate for loss of habitat by management of remaining resources."

TABLE 9

ESTIMATED OPERATION AND MAINTENANCE COSTS
PROPOSED TERRESTRIAL MANAGEMENT PLAN

Personnel

One full-time wildlife biologist		$ 20,600
One full-time maintenance engineer		20,600
One part-time forestry and wildlife technician (seasonal when practical)		2,100
	SUB-TOTAL	$ 43,300

Other

Equipment		$ 38,200
Habitat Management		5,000
Road Maintenance		5,000
Operations		10,000
	SUB-TOTAL	$ 58,200
	TOTAL	$101,500
	Rounded	$102,000

Fishery Management. The reservoir would provide both a warm-water and cold-water fishery with the installation of multiple-level outlets. The reservoir would offer a more stable, higher quality sport fishery resource than the ponds and streams currently present within the proposed impoundment area. The R.I. Division of Fish and Wildlife supports this conclusion. Based on this information, the fisheries management plan proposed in the EIS is revised to reflect fishery enhancement as opposed to fishery mitigation. The State of Rhode Island supports management for warm-water and cold-water fisheries in Big River Reservoir.

All fishery development and annual operation and maintenance costs are considered recreation and are attributable to the purpose of enhancement rather than mitigation.

Subimpoundments. The proposed Big River Reservoir includes creation of subimpoundments at the edge of the pool (below elevation 300 feet NGVD). This would partially mitigate wetland losses due to project implementation. Three sites, totalling approximately 90 acres, have been identified by the USFWS as possible locations for subimpoundments as shown on Plate 9 in the Feasibility Report. The 90 acre area was determined from a 4-foot contour interval topographic map, and includes only those areas under 4 feet or less of water. Maximum depth and acreage of the subimpoundments, taking into consideration grading operations to create more shallow areas, would be specified in future planning stages. The proposed project includes construction of subimpoundments as follows:

1. An 8-acre site located where the Congdon River would enter the reservoir which is in mixed growth forest. Elevations in this area range from 296 to 300 feet NGVD.

2. A 12-acre site located upstream from Sweet Pond near the New London Turnpike which is presently a forested wetland. Elevations range from 292 to 300 feet NGVD.

3. A 70-acre site located in the Mud Bottom Brook area. This area is also a forested wetland with elevations ranging between 292 and 300 feet NGVD.

Field surveys of the project area indicated that these would be the most appropriate sites for subimpoundments within the project area. The Mud Bottom Brook area is particularly suitable because it is relatively flat. The other sites would be improved by grading to create more shallow areas.

The type of wetland management with the subimpoundments would depend on the management of the reservoir. Reservoir operation would determine whether or not water levels in the subimpoundments would remain fairly constant or be allowed to fluctuate.

Response to U.S. Fish and Wildlife Service Recommendations. In compliance with ER 1105-2-50, p. 2-9, the following is a point-by-point response to recommendations contained in the Fish and Wildlife Coordination Act Report prepared by the U.S. Fish and Wildlife Service in 1979.

Recommendation #1: "The remaining area between the proposed reservoir pool and the boundary of the Management Area be utilized for mitigation of wildlife resource losses. These lands be managed in accordance with the concepts of the plans presented in this report."

Response: The proposed mitigation plan incorporates several of the measures recommended by the USFWS for management of the reservoir watershed lands.

Wildlife management practices, as suggested by USFWS, are proposed for the deciduous/evergreen forest/shrubland habitat. Management practices would include selective cutting on a 10-year basis, retention and creation of den trees, mast trees, low cover and brush piles, pruning and thinning, and prescribed burns and plantings. These practices would be intensively carried out in the southern portion of the reservoir, with access for small game, deer and waterfowl hunting provided on a seasonal basis. The northern and eastern portions of the reservoir would be managed for wildlife only to the extent that would be compatible with the recreational use proposed for the area. The area north of Route I-95 would be managed as a wildlife sanctuary.

Management practices for the sand and gravel pits, agricultural and open lands would be carried out for wildlife species typical of open country. The USFWS recommended that pit areas should be graded, topsoiled and seeded in addition to plantings for cover. Grading only is provided in the proposed project. Grading would allow natural succession of native vegetation types, which would increase species diversity and provide nesting, denning, or perching sites for many wildlife species. As recommended by USFWS, the 250 acres of agricultural and open fields would be kept open with management directed toward increasing existing food supplies.

The proposed project also includes management practices as recommended by USFWS for the scrub/shrub and forested wetland habitat, and also creation of subimpoundments identified by USFWS. Three sites, totalling approximately 90 acres have been proposed for subimpoundments. These subimpoundments would partially mitigate wetland losses due to project implementation.

Recommendation #2: "An additional 5,800 acres of land be acquired, developed and managed for wildlife in order to compensate for wildlife resource losses."

Response: The USFWS position is that the acquisition of 5,800 acres of forest and wetland habitat would represent 100 percent mitigation of wildlife losses.

In accordance with the Fish and Wildlife Coordination Act, the Corps must develop a plan which presents justifiable means and measures for wildlife resources that should be implemented to obtain maximum overall project benefits. This does not necessarily have to include 100 percent mitigation of lost resources. For this feasibility stage of study, proposed management of the surrounding reservoir lands represents the level of fish and wildlife mitigation which the Corps feels is viable and justifiable and in the public interest in conjunction with the proposed Big River Reservoir. The recommended Corps mitigation plan would be on lands contiguous with the impoundment area. Management activities would thus be more concentrated and cost-effective. Acquisition and management of lands beyond the immediate influence of the impoundment as inferred by the USFWS would aggravate socio-economic impacts of the reservoir. Political considerations would be compounded as new real estate acquisition burdens would likely be in areas where project water supply benefits would not be appreciated. The Corps proposal avoids additional land acquisition to preclude associated socio-economic and political complications. Additionally, the USFWS did not identify where in Rhode Island 5,800 acres of this specialized habitat would be available for mitigation.

Although the State of Rhode Island supports off-site mitigation, officials have stated that the cost of purchasing 5,800 acres would be very high and it is unlikely that this mitigation proposal would be

supported. State fish and wildlife officials have noted that the purchase of 2,000 acres of fisheries and wildlife habitat, much of it wetlands, may approach more complete mitigation than the 5,800 acres specified by USFWS.

Recommendation #3: "The Rhode Island Division of Fish and Wildlife be designated as the agency to manage fish and wildlife resources on all project lands and waters, and funds be provided to that agency for initial development, plus annual operating and maintenance costs."

Response: The Corps agrees with this recommendation, stating in the EIS that the Rhode Island Department of Environmental Management, Division of Fish and Wildlife would have some responsibility for management programs. However, the extent of the State's participation would be dependent on the cost-sharing policy that would be instituted.

Recommendation 4: "The minimum downstream release from Big River Reservoir be increased from 6 cfs to 18 cfs."

Response: As discussed and agreed to with the State of Rhode Island, a minimum average downstream release equal to the 10-year frequency, 7-day minimum flow rate would be implemented. The flow rate determined, would be the minimum flow considered necessary to maintain adequate waste assimilation levels downstream.

Recommendation #5: "That studies identified in this report be funded as a project cost in order to determine:

a. The probable impact of changes in stream flow regimen upon downstream environmental characteristics in the Flat River Reservoir and the South Branch and mainstem Pawtuxet Rivers.

b. The productivity and standing crop of fish and invertebrate populations in the project area.

c. If a multiple level outlet and removal of organic material is required in order to produce a cold-water fishery in the reservoir.

d. The type and quality of the potential reservoir fishery that should be addressed in the final fishery management plan.

e. The feasibility and costs of development and maintenance of three subimpoundments and opportunities for additional wetland developments within the reservoir pool.

f. The location and management potential of the 5,800 acres of additional land required to compensate for wildlife resource losses."

Response:

a. The overall effect of the Big River Reservoir on downstream flows would be determined when the reservoir's operational characteristics are finalized, should advanced engineering and design studies be authorized. Scituate Reservoir and Flat River Reservoir operations, and industrial and potential hydropower usage in downstream areas would be taken into consideration in evaluating the reservoir's effect on downstream environmental characteristics.

b. The productivity and standing crop of fish and invertebrate populations in the Big River Reservoir area are discussed in the Aquatic Ecosystem Assessment Report which is included in Appendix H - Recreation and Natural Resources. Field surveys were conducted at Flat River Reservoir, Tarbox Pond, Capwell Mill Pond, Big River, Carr River, Nooseneck River and in areas outside the boundary of the proposed reservoir. Phytoplankton, periphyton, zooplankton, benthic macroinvertebrate, finfish, and reptile and amphibian populations were studied. If warranted, additional aquatic studies would be carried out during future stages of project planning.

c. A multiple level outlet has been included in the design of the Big River dam. Stripping of organic material would not be included because of excessive costs. Although stripping the reservoir area of organic material would be desirable for establishment of a cold-water fishery, it is not considered absolutely essential. The configuration of the reservoir, plus multi-level outlets would favor a cold-water fishery.

d. A warm-water and cold-water fishery would exist in the Big River Reservoir. Populations of warm-water species such as sunfish, pickerel and perch would be self-sustaining. The cold-water fishery would be managed through a stocking program. Stocking and management programs would be the responsibility of the Rhode Island Department of Environmental Management, Division of Fish and Wildlife. The quality of the potential reservoir fishery is expected to be very good. Further temperature simulation and dissolved oxygen studies would be carried out during the advanced engineering and design stage of project planning.

e. Field surveys of the areas proposed by USFWS for subimpoundments determined that they would be the most appropriate areas within the project site. The approximately 70 acre site in the Mud Bottom Brook area has a very uniform elevation. The other sites could be improved by grading to create more shallow areas. Management practices proposed for the forested and shrub/scrub wetland habitat are described in the EIS.

In summary, development and maintenance of three subimpoundments is most feasible and there are opportunities for management of additional wetland habitats in the project area.

f. Refer to the response to Recommendation #2 concerning additional land acquisition.

RECOMMENDATIONS

The Division Engineer recommends that construction of a dam and reservoir on the Big River in Coventry and West Greenwich, Rhode Island, be authorized for flood control, water supply, and recreation, essentially as described in this Supplemental Report, with such modifications as in the discretion of the Chief of Engineers may be advisable, at a total project first cost currently estimated at $71,127,000.

The Division Engineer recommends that construction authorization for the Big River Reservoir project be subject to cost sharing and financing arrangements that are satisfactory to the President and the Congress. This recommendation is made with the provision that, prior to implementation of the project, non-Federal interests will, in addition to the general requirements of law for this type project, furnish assurances satisfactory to the Secretary of the Army that they agree to comply with the following requirements:

(1) Provide all lands, easements and rights-of-way necessary for implementation of the project;

(2) Hold and save the United States free from damages, including damages from water rights claims, due to construction of the project, except damages due to the fault or negligence of the United States or its contractors;

(3) Maintain and operate all features after completion in accordance with regulations prescribed by the Secretary of the Army, with the understanding that the annual cost of on-site operation and maintenance allocated to flood control, an amount currently estimated at $40,000, would be reimbursed by the United States.

(4) Repay all costs allocated to water supply in accordance with the Water Supply Act of 1958 (PL 85-500) as amended;

(5) Protect channels and floodplain areas downstream of the project from encroachments which would adversely affect reservoir operation;

(6) Exercise to the full extent of their legal capability, control to prohibit the removal of water from the watershed which would affect the reservoir's water supply storage and the development of dependable stream regulations;

(7) In accordance with the provisions of the Federal Water Project Recreation Act (PL 89-72) as amended:

a. Administer project land and water areas for recreation.

b. Pay, contribute in-kind, or repay (which may be through user fees) with interest, one-half of the separable cost of the project allocated to recreation.

c. Bear the costs of operation, maintenance and replacement facilities for recreation with the understanding that the annual cost of operation and maintenance allocated to joint use recreation costs an amount currently estimated at $6,000, would be reimbursed by the United States.

C. E. EDGAR, III
Colonel, Corps of Engineers
Commanding

OTHER RELATED INFORMATION

Considerations For Use of Project Lands. The project lands include areas that would provide opportunities for both recreation development and wildlife management practices.

After inundation, approximately 4,700 acres of habitat would remain within State ownership that can be managed to mitigate for losses to wildlife resources.

Approximately 2,000 acres are located in the southern portion of the proposed reservoir, bordered by the New London Turnpike. This upland habitat would be available for intensive wildlife management, and would be fairly isolated from other portions of the reservoir.

Acreage located in the northern and eastern portions of the proposed reservoir would also be available for wildlife management. However, management practices carried out here would only be those that are compatible with the recreational use proposed for the area. Management in these areas would emphasize improving habitat for those wildlife species tolerant of people. Techniques could include selective plantings and cuttings, creation of cover, and the addition of nesting structures. Although these practices would also be carried out in the southern intensive management area, they would be modified as necessary to provide habitat for game and species in the hunting areas.

Wildlife management in areas used for recreation is common practice on most Corps projects in New England. A good example is at the Birch Hill Dam project in Massachusetts where approximately 4,000 acres of this 4,400 acre dry bed flood control reservoir are leased to the State of Massachusetts for both fish and wildlife management as well as intensive recreational use. (The term dry bed reservoir is used for an impoundment that is normally held empty, filling only during major flood events). Recreation facilities at Birch Hill consist of a 200 site campground, a large beach and picnic area at a natural lake within the reservoir area, and an extensive multi-use trail system.

Wildlife management programs consisting of food plot plantings, timber stand improvement, mowing of fields and brush, stocking game birds and fish, and improving access for hunters are carried out year round immediately adjacent to and surrounding the relatively small acreage developed for recreation, with total compatibility. In fact, the Birch Hill Reservoir area is one of the most important and heavily used areas in Massachusetts for both fish and wildlife management, including hunting and fishing, and intensive recreation.

Reservoir Site Preparation. With regard to reservoir site preparation, the proposed Federal project includes clearing and grubbing only. Stripping of organic material is not included because of excessive costs. Although complete stripping of the reservoir area would be desirable for

establishment of a cold-water fishery, it is not considered absolutely essential. The configuration of the reservoir plus multi-level outlets would favor a cold-water fishery.

Executive Order 11988 Compliance. The proposed action, development of a multi-purpose reservoir on the Big River would include water supply and recreational uses as well as serve to reduce downstream flood damages. The proposed action or dam is by its nature required to be in the base flood plain.

Public review of the potential for inclusion of a flood damage reduction function at the Big River project dates back to early in the study and was included as an alternative plan at various public meetings held since 1975.

Ten detailed flood control plans were evaluated in the study. These plans included alternatives to the proposed action and consisted of: 1) alternative diversion tunnels at Natick, 2) joint local protection projects at Warwick and Elmwood Avenues, 3) acquisition of flood-prone properties in the Norwood section of Warwick, 4) no action and 5) a nonstructural plan. Through the planning process it was determined that all plans involving the Natick diversion tunnel were publicly unacceptable. The local protection works were found not viable for several reasons including economic efficiency and engineering feasibility based on detailed foundation and hydrologic analysis. A No Action program was rejected by the public as non-responsive and the primarily nonstructural plan had a significantly lower than unity benefit-to-cost ratio.

Plans found viable after evaluation of detailed alternatives included the Warwick Avenue local protection works, the Norwood land acquisition plan and construction of the proposed action, the multi-purpose reservoir on the Big River. Lack of local support and ability to cost share has caused the Warwick element to be dropped from further consideration. The Norwood land acquisition is now being evaluated for implementation under Section 205 Continuing Authorities Program.

Impacts of the proposed action associated with the inclusion of a flood damage reduction function at Big River includes adding about 3 feet to the height of dam with a water supply only function, an inundation of an additional 0.25 square mile.

Mitigation measures to minimize the impacts of the proposed action are described in the EIS. These include proposed management of surrounding reservoir lands for wildlife purposes.

Following completion of the detailed plan formulation the Division Engineer, New England Division reviewed and evaluated in depth, in view of the overall public interest, all documents concerning the proposed action and the stated views of the public. He recommended as one element of the basin's flood damage reduction plan the implementation of the proposed action.

The Big River Reservoir as formulated and proposed, therefore is in compliance with the requirements of Executive Order 11988.

Section 404 Evaluation. The Evaluation contained in the Feasibility Report was prepared in accordance with September 1975 guidelines. Upon review of the evaluation with regard to December 1980 guidelines, it was determined that the evaluation met the intent and requirements of these guidelines as well.

The 404 Evaluation is included in the Environmental Impact Statement in conformance with Section 404(r) of the Federal Water Pollution Control Act of 1972, amended as the Clean Water Act, December 27, 1977.

Local Cooperation. The following letter received from Rhode Island Governor J. Joseph Garrahy dated 12 January 1982 is considered sufficient in scope and commitment to serve as the basis for local project sponsorship.

State of Rhode Island and Providence Plantations

EXECUTIVE CHAMBER, PROVIDENCE

J. Joseph Garrahy
Governor

January 12, 1982

Colonel C. Ernest Edgar III
Division Engineer
Corps of Engineers
U.S. Army Engineer Division, N.E.
424 Trapelo Road
Waltham, MA 02254

Dear Colonel Edgar:

The State of Rhode Island remains committed to the proper development and management of its water resources both to satisfy present requirements and to insure that the long term needs of the state's population and economy are satisfied. Given this commitment, we consider it essential that the Big River Reservoir be developed and that such development provide for flood damage reduction and outdoor recreation opportunities in addition to water supply. We further believe that the Big River Reservoir proposal described in your Interim Feasibility Report is supportive of the state's commitment to multiple use development of the reservoir. Given this understanding, I wish to indicate my continued support of the Corps effort to bring this project before Congress for early authorization. We believe that such authorization would further the best interests of the State of Rhode Island.

The State of Rhode Island will, therefore, comply with all non-federal responsibilities under the Water Supply Act of 1958 and the Federal Water Project Recreation Act. We would anticipate participation in the construction, operation and maintenance of the reservoir as a multi-purpose flood control, water supply and recreational facility as proposed in your Interim Feasibility Report. In furtherance of this intent, the State of Rhode Island stands ready to enter into firm agreements at the appropriate time to provide the non-federal share of project costs. This commitment

must, of course, be conditioned on satisfactory resolution of existing ambiguities in the state-federal funding formula and reaffirmation of the final designs economic and environmental viability. I am confident given our past close operation that these conditions can and will be met.

Sincerely,

J. Joseph Garrahy
GOVERNOR